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Abstract— **The crowdsourcing paradigm (i.e., people while moving provide data from different places) can play a fundamental role in transforming users in significant actors in society. In the last years, several crowdsourcing services have been developed to allow citizens to collaborate collecting data about urban accessibility, but focusing mainly on physical disabilities. The project Personalized Interactive Urban Maps for Autism (PIUMA) aims to help people with Autism Spectrum Disorder (ASD) move and live within cities by means of a crowdsourced personalized map. The map is populated with comments and reviews by people with ASD and caregivers, in order to highlight places, routes, and activities (e.g. less crowded routes, quiet places, ways to socially behave in different places) for making ASD people's daily lives more comfortable.**

Keywords— Crowdmapping, Inclusive Smart City, Autism

I. INTRODUCTION

Participation of the citizen in the city life is one of the core pillar of the notion of smart city [1]. Participation can help to transform a smart city in an inclusive city. As defined by Douglas (2003), an inclusive city is one that "values all people and their needs equally. It is one in which all residents- including the most marginalized of poor workers- have a representative voice in governance, planning and budgeting processes, and have access to sustainable livelihoods, legal housing and affordable basic services" [2].

ICT can support democratic participation and sharing of information through crowd-sourcing and via open source platform. In particular, the crowdsourcing paradigm, i.e., people while moving collect data from different places, can play a fundamental role in the process [3]. It can transform users in significant actors in society, becoming the authors of the data.

Participation is indeed more complex for people with some kind of cognitive disability or neurological differences (as known as "neurodiversity" [4]) who still face a variety of barriers. Autism Spectrum Disorders (ASD) are characterized by the presence of persistent deficits in social communication and interaction across contexts and deficits in social-emotional reciprocity accompanied by the presence of restricted, repetitive patterns of behavior, interests or activities and hypo/hyper reactivity to sensory stimuli. [5]. Related to social interactions, ASD people can experience loneliness and anxiety [6]. Their engagement in social events is limited and they reported isolation and communication challenges [7].

In the last years, several crowdsourcing services have been developed to allow citizens to collaborate collecting data about urban accessibility, but focusing mainly on physical disabilities [8, 9]. The PIUMA project [10] wants to provide a spatial support to ASD people, in the form of a personalized crowdsourced map. This tool can improve not only the real life of the person, favoring independent living, but also her participation to the urban life. In fact, the system will have visible impacts on the independency of such persons in moving across their city, in managing their daily tasks and in interacting with other people. This, in turn, will produce a reduction of the need of continuous assistance by caregivers and social operators, and possibly a decrease of the need of behavioral therapies as well. The system aims also at producing impacts on the sense of self-efficacy and empowerment of people with cognitive problems, who will be allowed to actively contribute to a collective goal that may benefit other people as well as themselves by contributing to the crowdsourced data collection.

II. CROWSOURCED MAP

The PIUMA project aims to support ASD people in moving and living their city by means of an interactive map. The map is able to support everyday movements by providing tailored helps for facing breakdowns from routines. Moreover, it is able to recommend items (POIs and activities) suitable to ASD people according to users' habits and interests. To do so, the map is *crowdsourced*, i.e. populated with POIs, comments, reviews, trails both by people with autism and caregivers, as well as anyone wishing to contribute to make ASD people's lives easier. People have the possibility both to add free comments in the form of text or tags, as well as to choose the features of the POI among a selected list of features. Such features have been selected by a pool of experts in ASD (physician, psychologists and neuropsychologist, caregivers and patients themselves) in order to reflect the *desiderata* of the majority of ADS people. They allow to express whether a place is -for example- silent or noisy, crowded or isolated, bright or dark, and this is immediately visible on a map as icons, as well as to rate it. In this way, the person can navigate the map to find interesting places for her. To this aim, we designed an interface that appears in overlay on the map, where the user can rate (from

0 to 4, using a slider) a place with reference to the following five features: i) level of noise; ii) level of crowding, iii) temperature, iv) level of brightness, v) spaciousness. Moreover, a global evaluation about the "comfort" of the place can be provided. Such information will create the domain knowledge base to be used as a source for the personalized recommendations provided by the system.

The implementation of the crowdmapping in PIUMA is based on FirstLife [11], a social network based on interactive maps (see fig.1). The interactive map is based on AngularJS, Ionic, Leaflet and OpenStreetMap. FirstLife is a flexible platform that can be adapted to different aims. Its architecture is composed of an interactive geographical map-based interface as a frontend and a backend aimed at managing and searching geographical data. It allows to insert and manage different kinds of POIs directly from the map, and supports crowdsourced data collection.

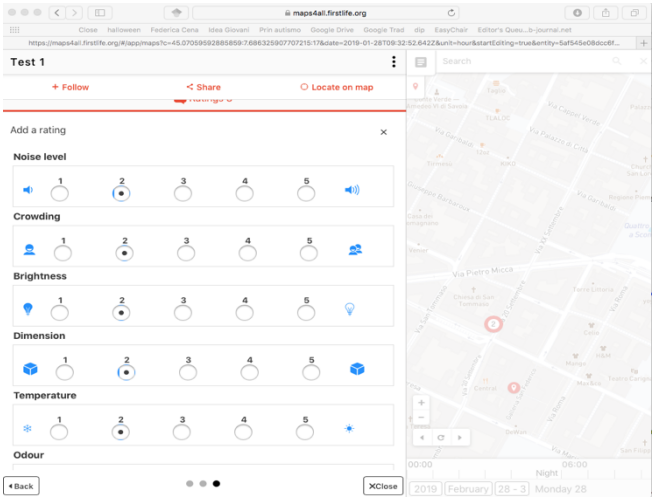

Figure 1. The crowdsourced map

III. CROWDSENSED RECOMMENDATION

System can proactively present some POIs of interest for the person, highlighting them in the interface. Crowdsourced information enriches the domain knowledge base used as a source for the personalized recommendations provided by the system. For example, the "not crowded routes" recommended to the ASD persons inclined to frequent isolated places might be extracted by the comments inserted by the users. For those who have developed a particular and exclusive disposition for mechanical relationships, the map could signal urban places that favor the observation of machines, such as a bench in a park pointing at the tram lines, on the basis of the information collected through crowdsourcing.

The system is able to recommend also social-suitable behavior by means of "scripts" describing how to "correctly" socially interact within certain contexts. For example, a "script" can describe all the steps that must be followed when entering in a post office. Such scripts are provided by therapists and caregivers, contributing to create a sort of "socially-suitable behavior" description that provides geo-localized hints on how to socially interact in a specific social place. If the scripts are not provided by professionals, they are validated by them before the publication on the map. When a user is localized in a specific place thanks to the mobile phone GPS, the specific scripts are loaded. The modality of presentation of the script is personalized according to the user's preferences about interaction (the system learns from past user's interaction with the system) and context features. Also the content of the script is customized according to the user's kind of cognitive disability, taking into account her specific issues.

To transformed crowdsourced data in recommendation, we needed to parse the community comments in order to detect users' opinions. We used mainly the structured annotations, but we plan to also exploit sentiment analysis to parse free text comments. Recommendations of POI from the crowdsensed set are the based on multiple factors: on user's ratings on POIs, interests and habits on the User Model, as well as context, and on ratings and interests of similar users according to a collaborative filtering paradigm [12].

IV. CONCLUSION

The project represents a first step towards making cities accessible to people with cognitive disabilities, not only to people with physical ones, as most commercial map-based services do. It can be adapted to other similar cases, such as persons with dementia (e.g. Alzheimer's disease) or traumatic brain injury, spatial agnosia and intellectual disabilities such as Down Syndrome.

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